PATENT ABSTRACTS OF JAPAN

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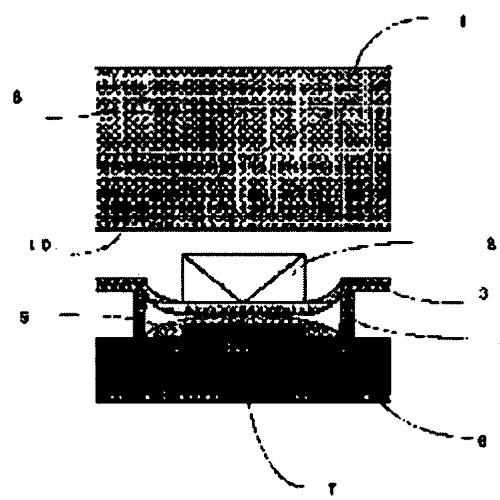
(54) OPTICAL ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent the problem of attraction and to embody an optical switching element which may be produced at a low cost without using large- scale equipment by adding an intermediate layer composed of material hardly giving rise to the attraction between a waveguide and reflection prism which attach and detach to and from each other.



SOLUTION: This optical element comprises the waveguide 1, the intermediate layer 10 which is disposed on the boundary of the waveguide 1, the reflection prism 2 which attaches an detaches to and from the waveguide 1 via the intermediate layer 10, a conductive movable film 3 which is joined to the reflection prism 2, a substrate 6, an electrode 7, an insulating layer 5 and a spacer 4 which disposes a space between a movable film 3 and the substrate 6. The element is constitute by disposing the intermediate layer 10 composed of the material hardly giving rise to the attraction between the waveguide 1 and the reflection prism 2, by which the attraction is prevented with the simple constitution. The optical switching element which may be produced at the low cost may be embodied without requiring the large-scale production equipment and much energy.

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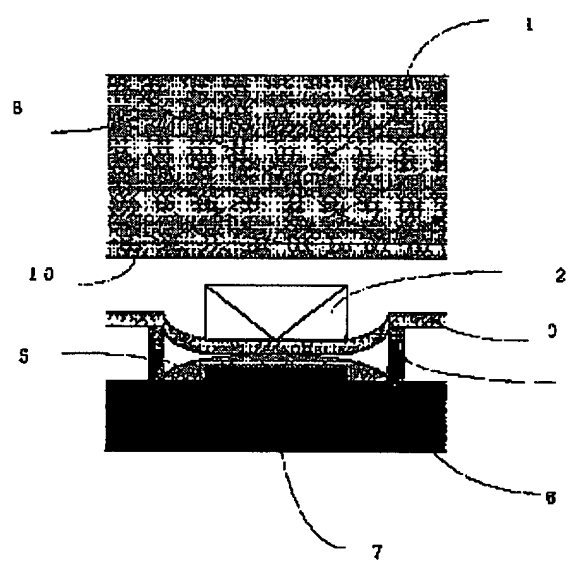
(54)【発明の名称】　光学素子

(57)【要約】
【課題】導波路に抽出面を接近及び離反させ、エバネッセント波結合させることにより光スイッチングを行う光学素子において、吸着による動作不良を防止するとともに、接近距離のばらつきに対するマージンを拡大する。また製造時及び廃棄時の環境汚染を防止する。
【解決手段】前記光学素子は、導波路1、前記導波路1に設けられた中間層10、前記中間層10を介して前記導波路1に接近及び離反する反射プリズム2、前記反射プリズム2に接合された導電性の可動膜3、基板6、電極7、絶縁層5、前記可動膜3と基板6の間に空間を設けるスペーサ4より構成される。



【特許請求の範囲】

【請求項１】導入光を全反射して伝達可能な全反射面を備えた導光部と、前記全反射面に対しエバネッセント波が漏出する抽出距離以下に接近する第１の位置、及び前記抽出距離以上に離れる第２の位置に移動可能な透光性の抽出面と、前記抽出面を移動せしめる駆動手段とを有し、さらに前記抽出面あるいは前記抽出面と相対する全反射面のいずれか一方または両方に、前記全反射面及び前記抽出面よりも屈折率が高く、かつ撥水性の材質よりなる１つ以上の層を具備することを特徴とする光学素子。

【請求項２】前記層の材質はダイヤモンドまたはダイヤモンド・ライク・カーボンであることを特徴とする請求項１記載の光学素子。

【請求項３】前記層の厚さは１０ｎｍから１００ｎｍの範囲のいずれかの値であることを特徴とする請求項１記載の光学素子。

【請求項４】導入光を全反射して伝達可能な全反射面を備えた導光部と、前記全反射面に対しエバネッセント波が漏出する抽出距離以下に接近する第１の位置、及び前記抽出距離以上に離れる第２の位置に移動可能な透光性の抽出面と、前記抽出面を静電力により移動せしめる駆動手段の一部であって、前記抽出面と一体で移動可能な第１の電極と、同様前記駆動手段の一部であって前記導光部に対して固定された第２の電極とを有し、さらに前記第１の電極あるいは前記第２の電極のそれぞれが相対する面のいずれか一方または両方に、前記第１の電極及び前記第２の電極とは異なる材質であってかつ撥水性である１つ以上の層を具備することを特徴とする光学素子。

【請求項５】前記層の材質はダイヤモンドまたはダイヤモンド・ライク・カーボンであることを特徴とする請求項４記載の光学素子。

【請求項６】前記層の材質はチッ化シリコンであることを特徴とする請求項４記載の光学素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、光学部材の接近及び離反により光をスイッチングする光学素子に関するものである。

【０００２】

【従来の技術】本発明に関わる従来技術について説明する。

【０００３】一方、図１５及び図１６に示すような、エバネッセント波結合を用いて光をスイッチングする光スイッチング素子が提案されている。以下に前記光スイッチング素子の動作を図に従って簡単に説明する。

【０００４】まず図１５に基いて説明する。前記光スイッチング素子は、導波路１、反射プリズム２、透光性を有した導電性の可動膜３、基板６、電極7、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。ここで、前記導波路１には適当な光源から光が供給される。前記導波路１は、内部の全ての界面において常に光が繰り返し全反射し、光線が満たされるように、光源から入射する光線の角度や、前記導波路１の各面の角度が設計されている。この状態では、前記導波路１に満たされた光の波長程度またはそれ以下の距離で近接するものがない限り、光は前記導波路１内部に閉じ込められている。

【０００５】さて、図上で前記導波路１の下方には、前記反射プリズム２が存在する。前記反射プリズム２は前記可動膜３の上方の面に接合されている。図１５の状態においては、前記電極7との間に電圧が印加されており、前記可動膜３は静電力により前記電極7側に前記絶縁層５を介して吸引され、弾性変形している。その結果前記反射プリズム２は、図の通り前記導波路１からは十分な距離をもって離反している。この状態では、前記導波路１内部の光は前記導波路１内部に閉じ込められたままであり、外に漏れ出ることはない。これを状態１とする。

【０００６】次に、図１６に基いて説明する。図１６は、前記状態１で前記可動膜３と前記電極7との間に印加されていた電圧を解除した場合の前記光スイッチング素子の様子を示す。前記印加電圧の解除により吸引力は失われ、弾性変形していた前記可動膜３は張力によって前記反射プリズム２を押し上げている。これにより前記反射プリズム２は前記導波路１に押し付けられあるいは接近せしめられる。その際、前記導波路１及び前記反射プリズム２の間で所謂エバネッセント波結合が生じ、前記導波路１内部の光は前記反射プリズム２に染み出してくる。さらに、染み出した前記エバネッセント光は前記反射プリズム２により反射され、前記導波路１を貫通して外部に出射する。言い換えれば、前記導波路１に閉じ込められていた光が取り出される。これを状態２とする。

【０００７】上記の状態１と状態２を前記電圧の印加及び解除により制御すれば、光スイッチングを行うことができる。また、前記の構成をマトリクス状に多数配置すれば、画像の表示が可能であることはいうまでもない。

【０００８】

【発明が解決しようとする課題】さて、前述の通り図１５及び図１６で示したような光スイッチング素子では、前記導波路１と前記反射プリズム２の接近及び離反の２状態を切り換えることによってスイッチングを行う。ここで、接近とは現実にはほとんどの場合接触であり、同様離反とは接触したものが解離する動作になると考えてよい。そして、従来の光スイッチング素子では、前記導

ころが解離できなくなり，その結果素子として動作不能に陥る場合があるという問題があった。また、前記反射プリズム２と反対側の面においても，前記可動膜３及び前記絶縁層の接触及び解離が行われるので、同様吸着の恐れがあった。前記吸着の主な原因は，接触部位における水分の付着である。前記吸着を防止するためには、製造時における水分の除去が肝要であり，十分乾燥した環境で製造する，あるいはさらに接触面に化学的な撥水処理を施す等の対策を行わねばならなかった。さらに、前記素子はその後パッケージで封止し，以後の水分の侵入を防止する必要があった。

【０００９】しかし、前記のような十分に乾燥した製造環境を実現するためには，大規模な設備が必要であった。またそうした設備の運転は多大な量のエネルギーを要し，省エネルギー、環境保全といった近年の製造業に対する要求に反するものである。一方，前記の化学的な撥水処理は長い時間を要する工程であり、コストアップの要因となっていたばかりか、多くの化学物質を用いることにより排出される廃液は、環境破壊の原因となっていた。さらに，撥水処理に用いる薬品の種類によっては製品の廃棄の際にも環境汚染を引き起こす可能性があった。

【００１０】また、上記の光スイッチング素子以外にも，繰り返し接触及び離反する部位を有する微小駆動構造を用いた素子は多数あり，これらにおいてもより簡単に吸着の問題を解決する方法が求められている。

【００１１】さらに、全く別な課題として、前記のようなエバネッセント波結合を応用した光スイッチング素子においては、前記導波路１から染み出すエバネッセント波は指数関数的に急速に減衰するため，光を取り出すには前記導波路１と前記反射プリズム２を十分接近させなければならないという問題があった。図１７は，前記導波路１と前記反射プリズム２の面間距離xに対する、取り出される光の量Pをプロットしたものである。図に示したように、面間距離が増大すると，急峻に光量は減衰する。よって十分な量の光を安定して取り出すためには，面間距離を十分小さく，かつ複数の反射プリズムを有する場合はばらつきなくすることが必要になる。しかし実際には製造時の誤差や，面の表面荒さ、前記反射プリズム２を複数個並べた場合のばらつき、経時変化等が存在する一方，面間距離に対するに光量変化は急峻である。よって、十分かつ均一な接近を実現するのは難しく，結果的にスイッチング不良を招いていた。

【００１２】そこで、本発明は、上記の吸着の問題を防止すると同時に、前記導波路１と前記反射プリズム２の接近距離のマージンを広げ、スイッチングを確実にした構成を有する光スイッチング素子を提供することを目的としている。

は，導入光を全反射して伝達可能な全反射面を備えた導光部と、前記全反射面に対しエバネッセント波が漏出する抽出距離以下に接近する第１の位置，及び前記抽出距離以上に離れる第２の位置に移動可能な透光性の抽出面と，前記抽出面を移動せしめる駆動手段とを有し，さらに前記抽出面あるいは前記抽出面と相対する全反射面のいずれか一方または両方に，前記全反射面及び前記抽出面よりも屈折率が高く、かつ撥水性の材質よりなる１つ以上の層を具備することを特徴とする。

【００１４】（２）本発明の光学素子は、第１項において，前記層の材質がダイヤモンドまたはダイヤモンド・ライク・カーボンであることを特徴とする。

【００１５】（３）本発明の光学素子は、第１項において，前記層の厚さが１０ｎｍから１００ｎｍの範囲のいずれかの値であることを特徴とする。

【００１６】（４）本発明の光学素子は、導入光を全反射して伝達可能な全反射面を備えた導光部と、前記全反射面に対しエバネッセント波が漏出する抽出距離以下に接近する第１の位置、及び前記抽出距離以上に離れる第２の位置に移動可能な透光性の抽出面と、前記抽出面を静電力により移動せしめる駆動手段の一部であって、前記抽出面と一体で移動可能な第１の電極と、同様前記駆動手段の一部であって前記導光部に対して固定された第２の電極とを有し、さらに前記第１の電極あるいは前記第２の電極のそれぞれが相対する面のいずれか一方または両方に、前記第１の電極及び前記第２の電極とは異なる材質であってかつ撥水性である１つ以上の層を具備することを特徴とする。

【００１７】（５）本発明の光学素子は、第４項において，前記層の材質がダイヤモンドまたはダイヤモンド・ライク・カーボンであることを特徴とする。

【００１８】（６）本発明の光学素子は、第４項において，前記層の材質がチッ化シリコンであることを特徴とする。

【００１９】

【発明の実施の形態】（実施例１）以下に本発明の実施例を示し、図を用いて説明する。

【００２０】図１及び図２は、本発明の一実施例である光スイッチング素子の構成を示す説明図である。

【００２１】まず図１に基いて説明する。前記光スイッチング素子は，導波路１，前記導波路１の界面に設けられた中間層１０，前記中間層１０を介して前記導波路１に接近及び離反する反射プリズム２，前記反射プリズム２に接合された導電性の可動膜３、基板６、電極７、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。

【００２２】ここで、前記導波路１には適当な光源から光が供給され，内部では全ての界面において常に光が全

度が設計されている。そしてこの状態においては、前記導波路1に満たされた光の波長より短い距離で近接するものがない限り、光は前記導波路1内部に閉じ込められている。

【0023】さて、図上で前記導波路1の下方には、前記反射プリズム2が存在する。前記反射プリズム2は前記可動膜3の上方の面に接合されている。まず、図1の状態においては、前記電極7との間に電圧が印加されており、前記可動膜3は静電力により前記電極7側に前記絶縁層5を介して吸引され、弾性変形している。前記反射プリズム2は、前記可動膜3上方に接合されているため、図の通り前記導波路1からは十分な距離をもって離反している。この状態では、前記導波路1内部の光は前記導波路1内部に閉じ込められたままであり、外に漏れ出ることはない。これを状態1とする。

【0024】次に、図2に基いて説明する。図2は、前記状態1で前記可動膜3と前記電極7との間に印加されていた電圧を解除した場合の前記光スイッチング素子の様子を示す。前記印加電圧の解除により吸引力は失われ、弾性変形していた前記可動膜3は張力によって前記反射プリズム2を押し上げている。これにより前記反射プリズム2は前記中間層10を介して前記導波路1に押し付けられあるいは接近せしめられ、前記導波路1及び前記反射プリズム2の間で所謂エバネッセント波結合が生じる。即ち、前記導波路1内部の光は前記反射プリズム2に染み出してくることになる。さらに、染み出した前記エバネッセント光は前記反射プリズム2により反射され、前記導波路1を貫通して外部に出射する。言い換えれば、前記導波路1に閉じ込められていた光が取り出される。これを状態2とする。

【0025】上記の状態1と状態2を前記電圧の印加及び解除により制御すれば、光スイッチングを行うことができる。また、前記の構成をマトリクス状に多数配置すれば、画像の表示が可能であることはいうまでもない。

【0026】尚、本実施例においては、前記可動膜3及び前記反射プリズム2は、前記可動膜3自身の弾性によって弾性的に支持されているが、いうまでもなく別途支持部材あるいは支持機構を用いる構成にしてもよい。また、前記導波路1と前記反射プリズム2を接近及び離反せしめる機構についても、図1及び図2に示した静電力による方法以外に多様な方法が考えられる。例えばピエゾアクチュエータの如き圧電素子による方法や、電磁的な方法を用いてもよい。

【0027】さて、従来の光スイッチング素子では、すでに述べたとおり前記導波路1と前記反射プリズム2の吸着による動作不良を招く問題があった。さらに、前記反射プリズム2と反対側の面においても、同様吸着の恐れがあった。前記吸着の主な原因は、接触部位におけるに接触面に化学的な撥水処理を施す等の対策を行わねばならなかった。さらに、前記素子はその後パッケージで封止し、以後の水分の混入を防止する必要があった。しかし、前記のような十分に乾燥した製造環境を実現するためには、大規模な設備が必要であった。またそうした設備の運転は多大な量のエネルギーを要し、省エネルギー、環境保全といった近年の製造業に対する要求に反するものである。一方、前記の化学的な撥水処理は長い時間を要する工程であり、コストアップの要因となっていたばかりか、多くの化学物質を用いることにより排出される廃液は、環境破壊の原因となっていた。さらに、撥水処理に用いる薬品の種類によっては製品の廃棄の際にも環境汚染を引き起こす可能性があった。

【0028】しかし本実施例では、吸着を起こしにくい材質で構成される前記中間層10を前記導波路1と前記反射プリズム2の間に配した構成とすることによって、簡単な構成で吸着を防止している。よって大規模な製造設備や多くのエネルギーを必要とせず、ローコストな光スイッチング素子が実現される。またここで、前記中間層10として、ダイヤモンド膜あるいはDLC（Diamond Like Carbon）等を用いれば、これらは帯電しにくい材質であるため、水分による吸着のみならず静電気による吸着も防止され、さらに繰り返し耐久性にも優れた光スイッチング素子とすることができる。ここで、ダイヤモンド膜であれば、透過率が高いため光量損失を小さくすることができる。一方DLCならば、容易に成膜が可能であり、ローコストで大量生産が可能である。また、前記ダイヤモンド膜及び前記DLCは炭素であるから生体にも無害であり、廃液や製品の廃棄による環境破壊を引き起こすことがない。

【0029】さらに、前記中間層10の屈折率が前記導波路1あるいは前記反射プリズム2より高い場合、もう一つの有益な効果を得ることができる。この点について以下に説明する。

【0030】前記のようなエバネッセント波結合を応用した従来の光スイッチング素子においては、前記導波路1から染み出すエバネッセント波の強さは距離に対して指数関数的に急速に減衰するため、光を取り出すには前記導波路1と前記反射プリズム2を十分接近させなければならないという問題があった。しかし実際には製造時の誤差や、面の表面荒さ、前記反射プリズム2を複数個並べた場合には距離のばらつき等が存在するため、完に十分かつ均一な接近を実現するのは難しかった。その結果、十分な光量が得られなかったり、光量に大きなばらつきを生じたりする恐れがあった。

【0031】しかし、以下に示すように、本実施例の如き前記中間層10を有する構成にし、かつ材質として前記導波路1あるいは前記反射プリズム2にガラス、前記

することができる。この様子を図3に示す。実線である曲線11が前記中間層10がない場合、点線である曲線12が前記中間層10がある場合の、前記導波路1と前記反射プリズム2の距離xに対する、前記導波路1から取り出される光量Pの変化を示したものである。まず、前記中間層10がない場合は、取り出される光量は距離が0のとき最大で、しかも鋭いピークを示す。そしてその後距離が増大するにつれて急速に単調減少する。一方、前記中間層10がある場合は、ある距離で緩やかなピークを持ち、なだらかに減少する曲線となる。とくに注目すべきは、ある距離x1からx2の範囲においては、前記中間層10がない場合よりも取り出される光量が大きくなっている点である。すなわちこれは、前記光スイッチング素子において、誤差や面の荒さ、ばらつき等によって、前記導波路1と前記反射プリズム2を十分接近しない場合が生じても、出力低下の度合いを小さく抑えるばかりか、増大させうるということを示している。また、前記の通りピーク部分のカーブが緩やかになるために、前記導波路1と前記反射プリズム2 の距離のばらつきに対しても取り出される光量の変動は少なくなる。言い換えれば、距離のばらつきに対するマージンを広げることができる。これは本実施例の光スイッチング素子をアレイ状またはマトリクス状に多数配置して画像表示装置等を構成した場合に、画素間の明るさのムラを抑えるのに効果がある。

【0032】またここで、前記中間層10の厚さを適当な値にすることによって、目的の距離における取り出し得る光量を最大にしたり、距離に対するばらつきを最小にしたりすることができる。この様子を図4に示す。図上で曲線11は前記中間層10がない場合、曲線13は前記中間層10の光学的厚みが波長の1／30場合、曲線14は前記中間層10の光学的厚みが波長の1／8の場合、曲線15は前記中間層10の光学的厚みが波長の1／3の場合である。ここで光学的厚みとは、物理的厚み即ち寸法と屈折率をかけたものである。前記中間層の付加により、取り出される光量の曲線は、距離が0のとき高く鋭いピークを示すものから、ある距離で緩やかなピークを持ちなだらかに減少する曲線へと変化する。また、図4にみられるように、前記中間層の厚さを変化させると、前記曲線の形状も変化する。すなわち、前記中間層10の光学的厚みが波長の1／30場合である前記曲線13では、前記中間層10がない場合である曲線11に対してピークの移動及び鈍化がみられる他、ピークの値は低下する。前記中間層10の光学的厚みが波長の1／8の場合である前記曲線14では、曲線13に対してさらにピークの移動及び鈍化とピーク値の低下が見られる。前記中間層10の光学的厚みが波長の1／3の場合である前記曲線15では、ピーク付近の曲線形状が極

11が最大光量となり、最も有利である。同様、距離x0からx1では曲線13が、距離x1からx2では曲線14が最も有利である。そこで、実際に光スイッチング素子を製作あるいは製造する場合に予想される、前記導波路1及び前記反射プリズムの距離及びその誤差、境界面の荒さ、ばらつき等によって、適当な前記中間層の厚みを選択すれば、もっとも効率よく光を取り出すことができる。図4に従えば、一般に予想される前記導波路1及び前記反射プリズムの距離及びその誤差、境界面の荒さ、ばらつきを考慮すると、前記中間層10の光学的厚みが波長の1／30から1／3の間のいずれかとするのが適当である。さらに具体的には、前記ダイヤモンド膜、あるいは前記DLCのような屈折率2．2前後の材質を用いた場合、その厚さは10nmから100nmの範囲のいずれかの値とするのが適当である。これにより、前記導波路1と前記反射プリズム2の吸着による動作不良がなく、光量のばらつきが少ないばかりか効率よく光を取り出しうる前記光スイッチング素子を実現することが可能である。

【0033】尚、本実施例では、前記反射プリズム2を前記導波路1に接近せしめ、染み出した前記エバネッセント光を前記反射プリズム2により反射せしめて、前記導波路1を貫通して外部に取り出す構成の光スイッチング素子を示したが、前記エバネッセント波結合を用いた光スイッチング素子の構造は他にも多様に考えらることができる。例えば、図1における前記反射プリズムを反射でなく透過させる光学部材とし、前記可動膜3、前記絶縁層5、前記電極7、前記基板6を透明部材とすれば、前記基板6側に前記エバネッセント光を透過させて取り出す光スイッチング素子を構成することができる。そして、これらいかなる構成の光スイッチング素子にあっても、前記エバネッセント波結合を行う境界面に本実施例で示したような適当な厚みを有する前記中間層を挿入すれば、本実施例と同様の効果、即ち吸着による動作不良がなく、光量のばらつきが少ないばかりか効率よく光を取り出しうる効果が得られるのはいうまでもない。

【0034】（実施例2）図5及び図6は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。実施例1では、前記中間層10を前記導波路1の側に形成していたが、図5及び図6に示したように、前記中間層10を前記反射プリズム2の側に形成してもよい。

【0035】本実施例の前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路1、前記導波路1と相対する面に中間層10を具備し、前記中間層10を介して前記導波路1に接近及び離反する反射プリズム2、前記反射プリズム2に接合された導電性の可動膜3、基板6、電極7、絶縁層5、前記可動膜3

き、前記光スイッチング素子の製造工程によってはより簡単に前記中間層１０を形成することができる。他の構成及び効果については実施例１と同様であるので、詳しい説明は省略する。

【００３６】（実施例３）図７及び図８は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。実施例１では、中間層１０としてダイヤモンド膜あるいはＤＬＣを用いていたが、代わりにチッ化シリコンを用いてもよい。

【００３７】本実施例の前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路１、前記導波路１の界面に設けられたチッ化シリコンよりなる中間層１０、前記中間層１０を介して前記導波路１に接近及び離反する反射プリズム２、前記反射プリズム２に接合された導電性の可動膜３、基板６、電極7、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。本実施例では、実施例１と同様吸着防止効果を得ることができる他、前記チッ化シリコンは成膜技術及び装置も一般化しているため、容易かつ安価に中間層１０を形成可能である。他の構成については実施例１と同様であるので、詳しい説明は省略する。

【００３８】（実施例４）図９及び図１０は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。本実施例は、実施例２の構成の前記中間層１０を、ダイヤモンド膜あるいはダイヤモンド膜あるいはＤＬＣからチッ化シリコンに変更したものである。

【００３９】本実施例の前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路１、前記導波路１と相対する面に中間層１０を具備し、前記中間層１０を介して前記導波路１に接近及び離反する反射プリズム２、前記反射プリズム２に接合された導電性の可動膜３、基板６、電極7、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。本実施例では、実施例３と同様に、容易かつ安価に中間層１０を形成可能である。他の構成については実施例２と同様であるので、詳しい説明は省略する。

【００４０】（実施例５）図１１は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。

【００４１】実施例１から４に示した本光スイッチング素子では、前記可動膜３の前記反射プリズム２と反対の面と前記電極7と間においても接触及び解離動作が行われる。よって、この部位においても、前記反射プリズム２側同様、吸着を招く恐れがある。そこで本実施例に示すように、吸着を起こしにくい物質からなる付加層１６を前記可動膜３の前記電極7と相対する面に形成し、吸着による制御不能、特性劣化を防止する構成にしてもよい。

【００４２】本実施例の前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路１、前記導波路１に接近及び離反する反射プリズム２、前記反射プリズム２に接合された導電性の可動膜３、前記可動膜３の前記反射プリズム２が接合されているのと反対の面に付加された付加層１６、基板６、電極7、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。前記付加層１６の材質の例としては、前記の実施例同様ダイヤモンド膜あるいはＤＬＣ、チッ化シリコン等が挙げられる。前記付加層１６の効果により、前記可動膜３の前記反射プリズム２と反対の面においても吸着による制御不能、特性劣化が防止され、耐久性と信頼性に優れた光スイッチング素子が実現される。

【００４３】また、前記付加層１６としてダイヤモンド膜あるいはＤＬＣあるいはチッ化シリコンのような絶縁体を用いるならば、前記付加層１６は前記絶縁層５を兼ねることができ、簡単な構成で絶縁機構と吸着防止を両立することができる。また、本構成を実施例１から４の構成と組み合わせれば、前記導波路１と前記反射プリズム２の吸着と、前記可動膜３と前記電極7の吸着を同時に防止した前記光スイッチング素子を実現することができる。

【００４４】他の構成及び効果については実施例１と同様であるので、詳しい説明は省略する。

【００４５】（実施例６）図１２は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。

【００４６】実施例５では、前記可動膜３の前記電極7との吸着を防止する付加層１６を、前記可動膜３側に付加していたが、本実施例に示すように、前記電極7の側に付加する構成にしてもよい。

【００４７】前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路１、前記導波路１に接近及び離反する反射プリズム２、前記反射プリズム２に接合された導電性の可動膜３、基板６、電極7、前記電極7の前記可動膜３に相対する面に付加された付加層１６、絶縁層５、前記可動膜３と基板６の間に空間を設けるスペーサ４より構成される。前記付加層１６の材質の例としては、前記の実施例同様ダイヤモンド膜あるいはＤＬＣ、チッ化シリコン等が挙げられる。前記付加層１６の効果により、前記可動膜３の前記反射プリズム２と反対の面においても吸着による制御不能、特性劣化が防止され、耐久性と信頼性に優れた光スイッチング素子が実現される。

【００４８】また、実施例５でも述べたように、前記付加層１６としてダイヤモンド膜あるいはＤＬＣあるいはチッ化シリコンのような絶縁体を用いるならば、前記付加層１６は前記絶縁層を兼ねることができ、簡単な構成で絶縁と吸着防止を両立することができる。

【００４９】また、実施例５と同様本構成を実施例１か

を同時に防止した前記光スイッチング素子を実現することができる。

【0050】他の構成及び効果については実施例1と同様であるので、詳しい説明は省略する。

【0051】（実施例7）図13は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。実施例1では前記中間層10を前記導波路1の側に形成し、実施例2では前記中間層10を前記反射プリズム2の側に形成していたが、図13したように、前記中間層10を前記導波路1及び前記反射プリズム2の両方に形成してもよい。

【0052】本実施例の前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路1、前記導波路1の界面に設けられた第1中間層17、前記導波路1と相対する界面に第2中間層18を具備し、前記第1中間層17及び前記第2中間層18を介して前記導波路1に接近及び離反する反射プリズム2、前記反射プリズム2に接合された導電性の可動膜3、基板6、電極7、絶縁層5、前記可動膜3と基板6の間に空間を設けるスペーサ4より構成される。本実施例では、前記第1中間層17及び前記第2中間層18にダイヤモンド膜あるいはDLC、チッ化シリコン等の吸着しにくい材質を用いることによって実施例1及び実施例2よりもさらに確実に吸着を防止することができる。さらに、表面粗さ、製造時のばらつき等で前記導波路及び前記反射プリズム2が接触できない場合が生じると、前記反射プリズム2の表面で反射が起き、結果的に光量損失を招く場合があるが、本実施例では前記第1中間層17及び第2中間層18の厚さを最適に設計することにより反射防止することが可能のため、より高効率のエバネッセント波結合を実現可能である。また、さらに多層化することにより反射防止効果を高めてもよい。他の構成及び効果については実施例1と同様であるので、詳しい説明は省略する。

【0053】（実施例8）図14は、本発明の他の一実施例である光スイッチング素子の構成を示す説明図である。

【0054】実施例5では吸着を起こしにくい物質からなる付加層16を前記可動膜3の前記電極7と相対する面に形成し、一方実施例6では前記電極7の側に形成したが、いうまでもなくその両方に前記付加層を形成してもよい。

【0055】前記光スイッチング素子は、適当な光源から入射した光線が満たされている導波路1、前記導波路1に接近及び離反する反射プリズム2、前記反射プリズム2に接合された導電性の可動膜3、前記可動膜の前記反射プリズム2が接合されているのと反対の面に付加された第1付加層19、基板6、電極7、前記電極7の前記ーサ4より構成される。

【0056】本実施例では、吸着を起こしにくい物質同士での接近及び離反となるので、さらに高度に吸着が防止され、より耐久性と信頼性に優れた光スイッチング素子が実現される。また、実際の成膜では、しばしば製造上の都合により目的の層以外に異なる層を挿入することが必要になる場合があるが、その際は前記第1付加層19及び第2付加層20を多層化してもよい。他の構成及び効果については他の実施例と同様であるので、詳しい説明は省略する。

【0057】

【発明の効果】本発明によれば、以下に示す効果がもたらされる。

【0058】（1）本発明の光学素子は、接近及び離反する導波路と反射プリズムの間に、吸着を起こしにくい材質で構成される中間層を付加することにより吸着を防止する構成のため、大規模な設備を用いずに製造可能である。よって繰り返し耐久性に優れながらローコストな光スイッチング素子が実現されるほか、従来の製品に比べて製造に要するエネルギーが縮小されるので、環境保全の観点からも優れている。さらに、製造時の誤差や、面の荒さ、前記反射プリズムを複数個並べた場合の前記導波路との距離のばらつき等によって、前記導波路と前記反射プリズムが十分接近しない場合が生じても、前記中間層の働きによって出力低下の度合い及びばらつきを小さく抑えることができる。とくに、前記中間層の光学的厚みを取り出そうとする光の波長の1／30から1／3の間のいずれかとすることにより、光量のばらつきが少なく、もっとも効率よく光を取り出しうる前記光スイッチング素子を実現することが可能である。その結果歩留まりも向上し、生産効率も大幅に改善される。また、前記中間層としてダイヤモンド膜あるいはDLC等を用いれば、水分による吸着のみならず静電気による吸着も防止される。よってさらに繰り返し耐久性にも優れた光スイッチング素子とすることができる。また、ダイヤモンド膜及びDLCは炭素であるから生体にも無害であり、廃液や製品の廃棄による環境破壊を引き起こすことがない。

【0059】（2）本発明の光学素子は、前記中間層を前記導波路の側に形成するほか、前記反射プリズムの側に形成してもよく、 その結果どちらも同様の効果を得ることができ、製造工程によって前記を選択すればより簡単に前記中間層を形成することができる。

【0060】（3）本発明の光学素子において、中間層としてチッ化シリコンを用いた場合、前記チッ化シリコンは成膜技術及び装置も一般化しているため、ダイヤモンド膜あるいはDLCの場合と同様吸着防止効果をより簡単に得られる一方で、より容易かつ安価に前記中間層

動膜の前記反射プリズムと反対の面においても、吸着を起こしにくいダイヤモンド膜あるいはＤＬＣ、チッ化シリコン等の物質からなる付加層を前記可動膜の前記電極と相対する面に形成した場合、前記面においても吸着による動作不良が防止され、耐久性と信頼性に優れた光スイッチング素子が実現される。また、前記付加層としてダイヤモンド膜あるいはＤＬＣのような絶縁体を用いた場合、前記付加層は前記絶縁層を兼ねることができ、簡単な構成で絶縁機構と吸着防止を両立することができる。

【００６２】（５）本発明の光学素子において、前記可動膜の前記電極との吸着を防止するダイヤモンド膜あるいはＤＬＣ、チッ化シリコン等からなる付加層を、前記電極の側に付加すれば、前項同様前記可動膜の前記反射プリズムと反対の面において吸着による制御不能、特性劣化が防止され、耐久性と信頼性に優れた光スイッチング素子が実現される。また、前記付加層としてダイヤモンド膜あるいはＤＬＣ、チッ化シリコンのような絶縁体を用いるならば、前記付加層は前記絶縁層を兼ねることができ、簡単な構成で絶縁と吸着防止を両立することができる。

【００６３】（６）前記中間層を前記導波路及び前記反射プリズムの両方に形成すれば、さらに確実に吸着を防止することができる。また、層の厚さを最適に設計することにより反射防止することが可能のため、よりエバネッセント波結合の効率が高い光スイッチング素子を実現可能である。また、さらに多層化することにより反射防止効果を高めて、高効率の光スイッチング素子を構成することが可能である。

【００６４】（７）吸着を起こしにくい物質からなる付加層１６を前記可動膜の前記電極と相対する面に形成し、さらに前記電極7の側にも形成すれば、吸着を起こしにくい物質同士での接近及び離反となるので、さらに高度に吸着が防止され、より耐久性と信頼性に優れた光スイッチング素子が実現される。

【図面の簡単な説明】

【図１】本発明の光学素子の一実施例を示す説明図。

【図２】本発明の光学素子の一実施例を示す説明図。

【図３】本発明の光学素子の一実施例を説明するための説明図。

【図４】本発明の光学素子の一実施例を説明するための説明図。

【図５】本発明の光学素子の他の一実施例を示す説明図。

【図６】本発明の光学素子の他の一実施例を示す説明図。

【図７】本発明の光学素子の他の一実施例を示す説明図。

【図８】本発明の光学素子の他の一実施例を示す説明図。

【図９】本発明の光学素子の他の一実施例を示す説明図。

【図１０】本発明の光学素子の他の一実施例を示す説明図。

【図１１】本発明の光学素子の他の一実施例を示す説明図。

【図１２】本発明の光学素子の他の一実施例を示す説明図。

【図１３】本発明の光学素子の他の一実施例を示す説明図。

【図１４】本発明の光学素子の他の一実施例を示す説明図。

【図１５】従来の光学素子の一例を示す説明図。

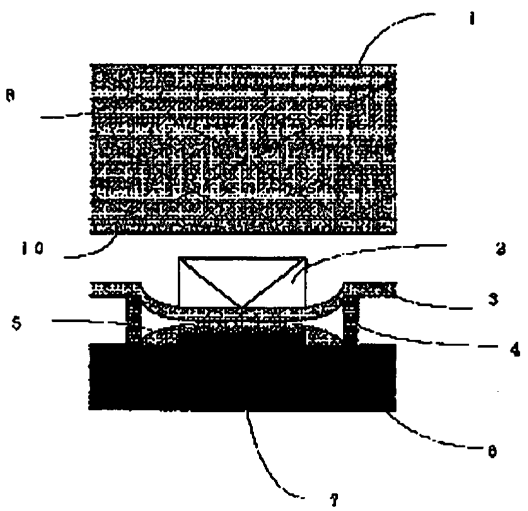
【図１６】従来の光学素子の一例を示す説明図。

【図１７】従来の光学素子の一例を説明するための説明図。

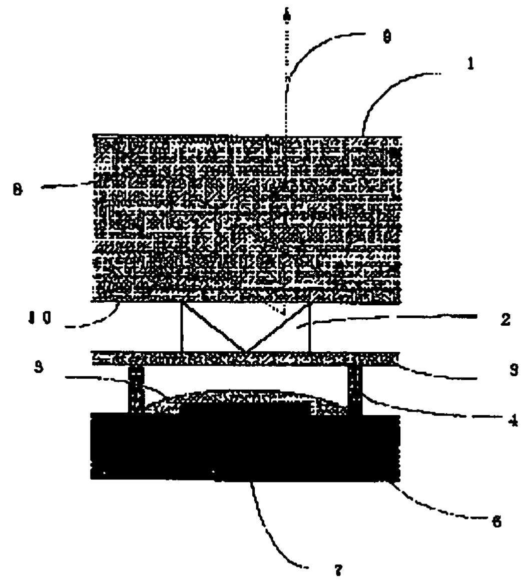
【符号の説明】

１　導波路
２　反射プリズム
３　可動膜
４　スペーサ
５　絶縁層
６　基板
７　電極
８　入射光
９　反射光
１０　中間層
１１　中間層がない場合の曲線
１２　中間層がある場合の曲線
１３　中間層の光学的厚さが光の波長の１／３０の場合の曲線
１４　中間層の光学的厚さが光の波長の１／８の場合の曲線
１５　中間層の光学的厚さが光の波長の１／３の場合の曲線
１６　付加層
１７　第１中間層
１８　第2中間層
１９　第1付加層
２０　第２付加層

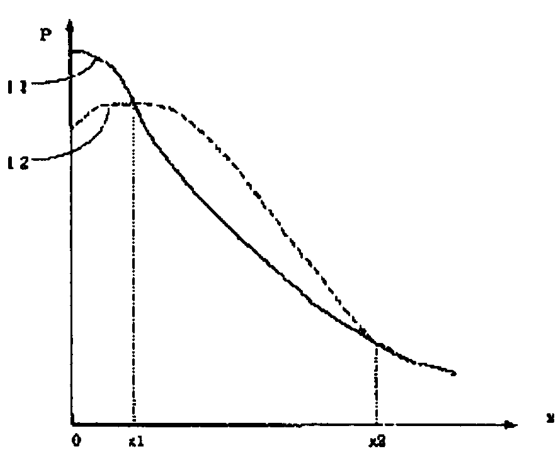
【図1】



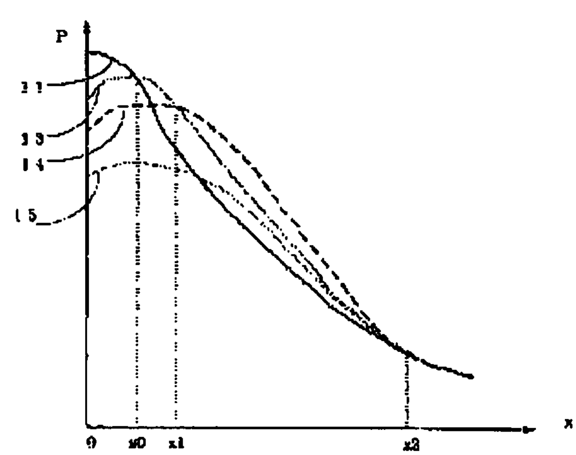
【図2】



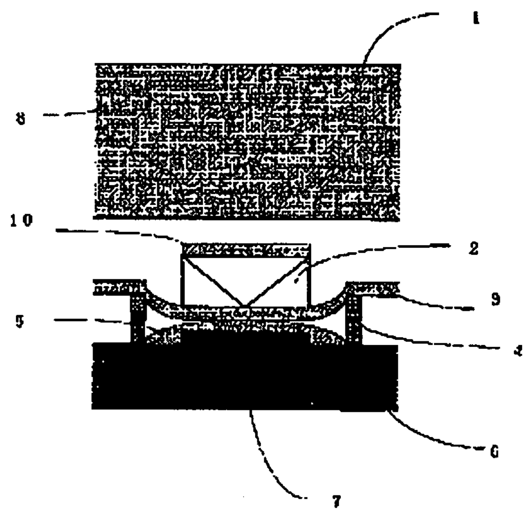
【図3】



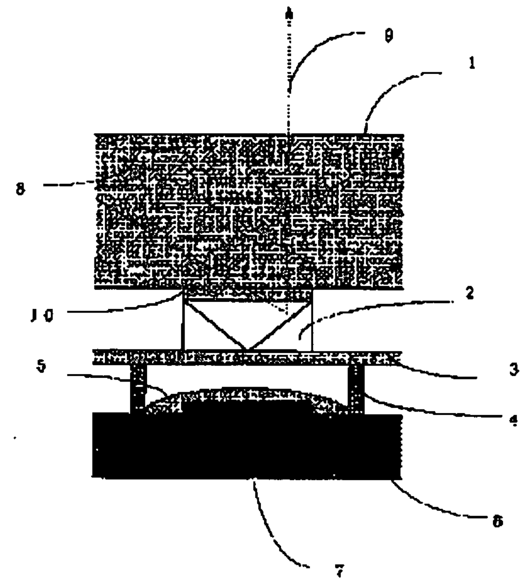
【図4】



【図５】



【図６】



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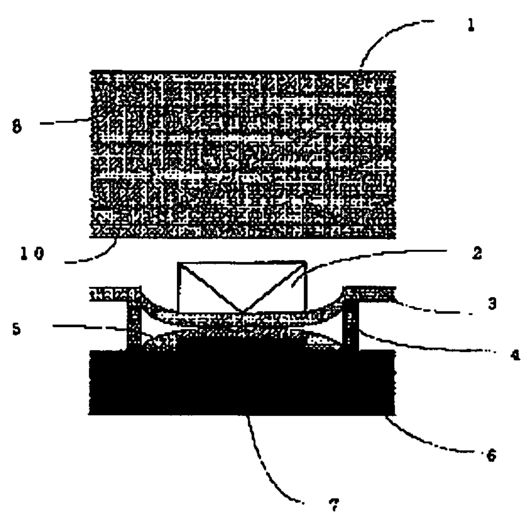

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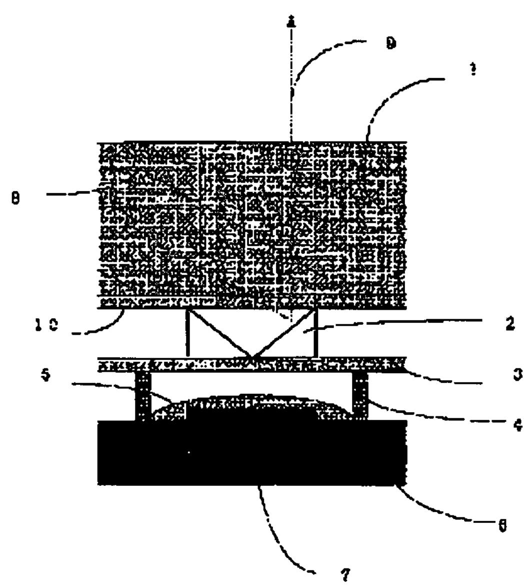
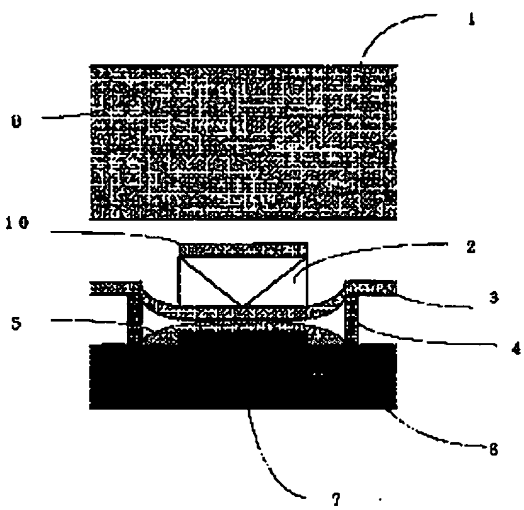
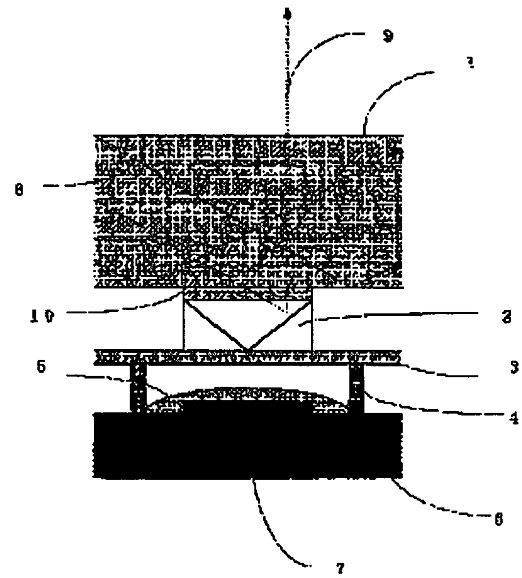


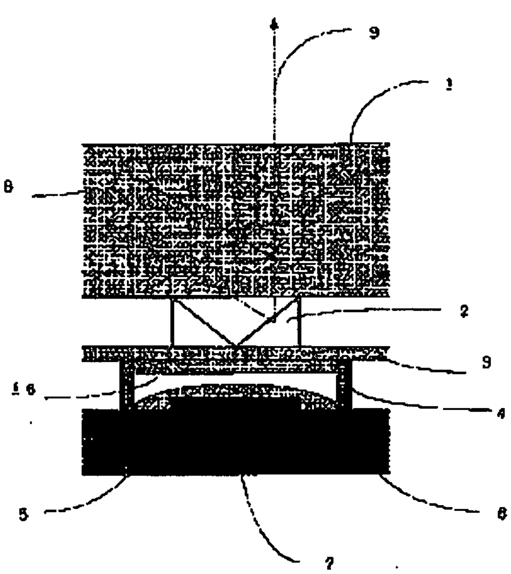
【図９】



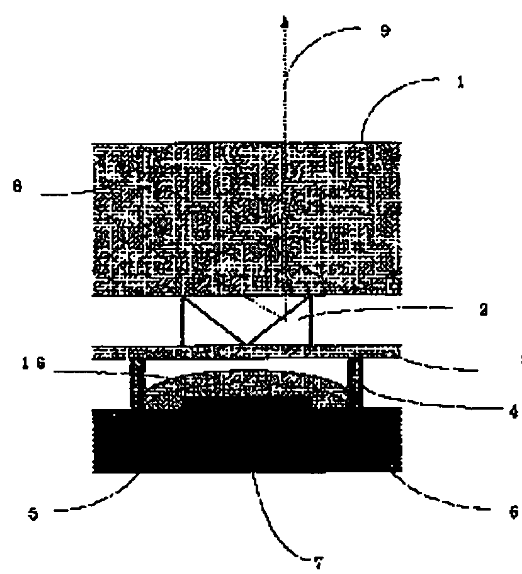
【図１０】



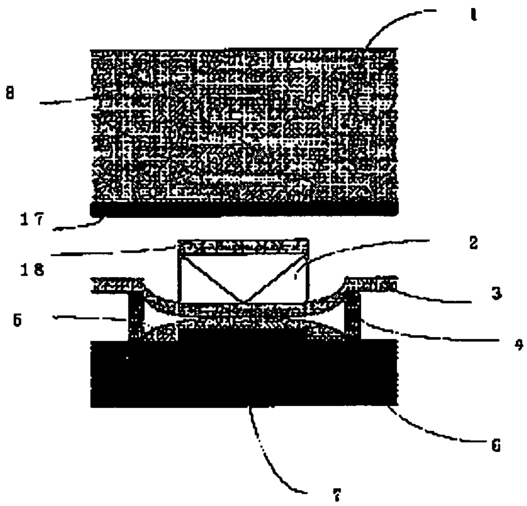
【図１１】



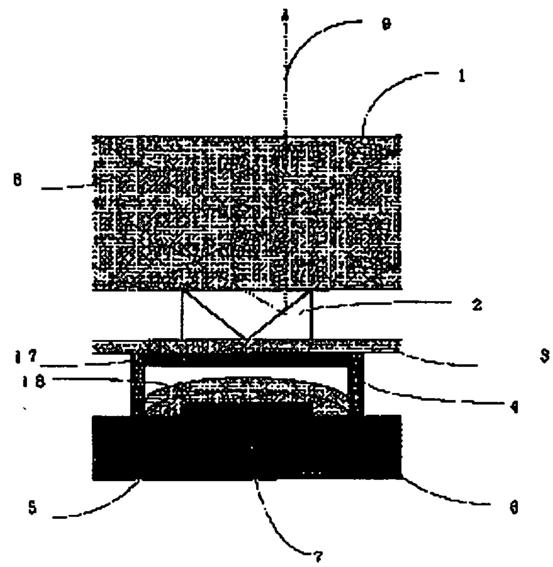
【図１２】



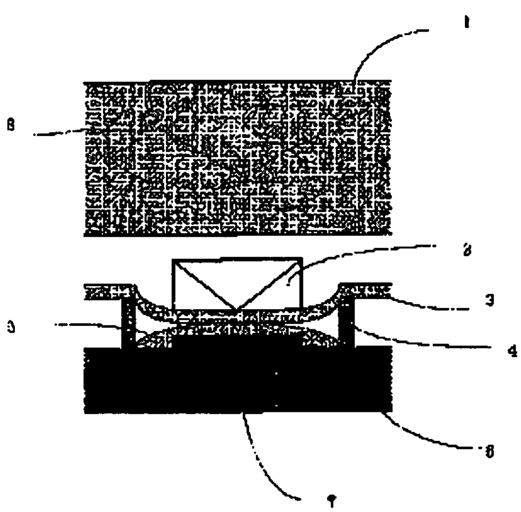
【図１３】



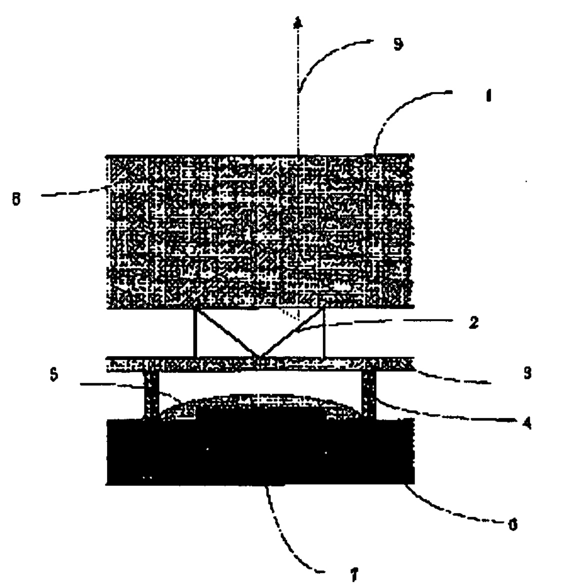
【図１４】



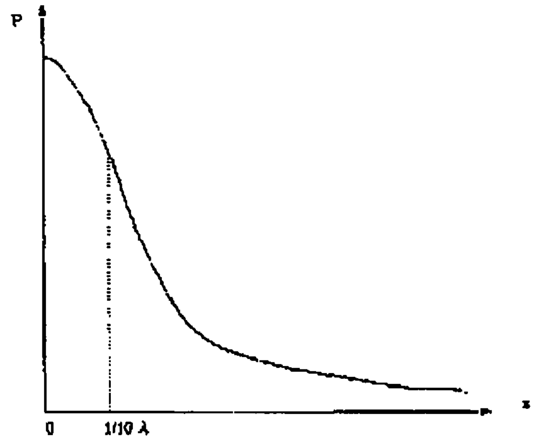
【図１５】



【図１６】



【図17】



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CLAIMS

[Claim(s)]
[Claim 1] The extract side of translucency movable in the light guide section which carried out total reflection of the introductory light, and was equipped with the total reflection side which can be transmitted, the 1st location close to below the extract distance that an evanescent wave leaks to said total reflection side, and the 2nd location left beyond said extract distance, The optical element characterized by providing one or more layers as for which a refractive index becomes both total reflection both [either or] which have the driving means to which said extract side is made to move, and face said extract side or said extract side further higher than said total reflection side and said extract side from the water-repellent quality of the material.
[Claim 2] The quality of the material of said layer is an optical element according to claim 1 characterized by being diamond[a diamond or]-like carbon.
[Claim 3] The thickness of said layer is an optical element according to claim 1 characterized by being one value of the range of 10 to 100nm.
[Claim 4] The extract side of translucency movable in the light guide section which carried out total reflection of the introductory light, and was equipped with the total reflection side which can be transmitted, the 1st location close to below the extract distance that an evanescent wave leaks to said total reflection side, and the 2nd location left beyond said extract distance, It is a part of driving means to which said extract side is made to move according to electrostatic force. The 1st electrode movable at said extract side and one, It has the 2nd electrode which is said a part of driving means similarly, and was fixed to said light guide section. The optical element characterized by providing one or more layers which said 1st electrode and said 2nd electrode are the different quality of the material, and are water repellence in both both [either or] which each of said 1st electrode or said 2nd electrode furthermore faces.
[Claim 5] The quality of the material of said layer is an optical element according to claim 4 characterized by being diamond[a diamond or]-like carbon.
[Claim 6] The quality of the material of said layer is an optical element according to claim 4 characterized by being a silicon nitride.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the optical element which switches light by approach and estrangement of an optical member.
[0002]

[Description of the Prior Art] The conventional technique in connection with this invention is explained.
[0003] The optical switching element which switches light on the other hand using evanescent wave coupling as shown in drawing 15 and drawing 16 is proposed. Actuation of said optical

switching element is briefly explained according to drawing below.
[0004] Based on drawing 15 , it explains first. Said optical switching element consists of the conductive movable film 3 joined to the reflecting prism 2 which approaches and deserts waveguide 1 and said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. Here, light is supplied to said waveguide 1 from the suitable light source. In all internal interfaces, light always carries out total reflection of said waveguide 1 repeatedly, and the include angle of the beam of light which carries out incidence from the light source, and the include angle of each side of said waveguide 1 are designed so that a beam of light may be filled. Light is confined in said waveguide 1 interior as long as there is nothing that approaches in wavelength extent of light or the distance not more than it filled with this condition by said waveguide 1.
[0005] Now, under said waveguide 1, said reflecting prism 2 exists on drawing. Said reflecting prism 2 is joined by the upper field of said movable film 3. In the condition of drawing 15 , the electrical potential difference is impressed between said electrodes 7, and said movable film 3 is being attracted through said insulating layer 5 at said electrode 7 side according to electrostatic force, and is carrying out elastic deformation. As a result, as drawing, said reflecting prism 2 had sufficient distance, and has deserted said waveguide 1. In this condition, the light of said waveguide 1 interior is confined in said waveguide 1 interior, and it does not leak and come out of it outside. This is made into a condition 1.
[0006] To a degree It explains based on drawing 16 . Drawing 16 shows the situation of said optical switching element at the time of canceling the electrical potential difference currently impressed between said movable film 3 and said electrodes 7 in said condition 1. A suction force is lost by discharge of said applied voltage, and said movable film 3 which was carrying out elastic deformation is pushing up said reflecting prism 2 with tension. Thereby, said reflecting prism 2 is pushed against said waveguide 1, or is made to approach. In that case, the so-called evanescent wave coupling arises between said waveguide 1 and said reflecting prism 2, and the light of said waveguide 1 interior oozes out to said reflecting prism 2. Furthermore, it is reflected by said reflecting prism 2, and said EBANESSENTO light which oozed out penetrates said waveguide 1, and it carries out outgoing radiation outside. In other words, the light confined in said waveguide 1 is taken out. This is made into a condition 2.
[0007] Optical switching can be performed if an above-mentioned condition 1 and an above-mentioned condition 2 are controlled by impression and discharge of said electrical potential difference. Moreover, if much aforementioned configurations are arranged in the shape of a matrix, it cannot be overemphasized that the display of an image is possible.
[0008]

[Problem(s) to be Solved by the Invention] Now, in an optical switching element as shown by drawing 15 and drawing 16 as above-mentioned, it switches by switching two conditions of approach of said waveguide 1 and said reflecting prism 2 and estrangement. Here, in almost all cases, approach is contact actually, and you may think the same way that it becomes the actuation which the thing in contact with estrangement dissociates. And in the conventional optical switching element, when said waveguide 1 and said reflecting prism 2 contacted, adsorption often arose among both, it becomes impossible to have dissociated the place which should be essentially dissociated according to membranous elastic force, and there was a problem that it may lapse into impossible of operation as a component as a result. Moreover, in

the field of said reflecting prism 2 and opposite side, since contact and dissociation of said movable film 3 and said insulating layer were performed, there was fear of adsorption similarly. The main causes of said adsorption are adhesion of the moisture in a contact part. In order to prevent said adsorption, removal of the moisture at the time of manufacture is important, and had to cope with manufacturing or giving a still more chemical water-repellent finish to the contact surface in the environment dried enough, etc. Furthermore, said component needed to be closed with a package after that, and needed to prevent mixing of future moisture.
[0009] However, in order to realize the fully dried above manufacture environments, the large-scale facility was required. Moreover, operation of such a facility requires a great quantity of energy, and is contrary to energy saving and the demand to a manufacture in recent years called environmental preservation. On the other hand, the aforementioned chemical water-repellent finish is a process which requires long time amount, and the waste fluid discharged by using the chemical of about [having become the factor of a cost rise] and many caused environmental destruction. Furthermore, the class of chemical used for a water-repellent finish may have caused environmental pollution also on the occasion of abandonment of a product.
[0010] Moreover, and the approach of solving the problem of adsorption more simply also in these is searched for. [the component using the minute drive structure of having the part which deserts / which deserts and repeat-contacts / besides the above-mentioned optical switching element]
[0011] Furthermore, as a completely different technical problem, since the evanescent wave which oozes out from said waveguide 1 in the optical switching element adapting the above evanescent wave coupling decreased quickly exponentially, there was [a problem of having to make said waveguide 1 and said reflecting prism 2 approach enough for taking out light]. Drawing 17 plots the amount P of the light taken out to the face to face dimension x of said waveguide 1 and said reflecting prism 2. If a face to face dimension increases as shown in drawing, the quantity of light will be decreased steeply. Therefore, in order to be stabilized and to take out sufficient quantity of light, it is necessary to vary and to lose a face to face dimension, when it has two or more reflecting prisms sufficiently small. However, while the error at the time of manufacture, dispersion at the time of putting two or more surface roughness of a field and said reflecting prisms 2 in order, aging, etc. exist in fact, quantity of light change is steep to a face to face dimension. Therefore, realizing enough and uniform approach had caused poor switching difficultly and as a result.
[0012] Then, this invention, The margin of the approach distance of said waveguide 1 and said reflecting prism 2 is extended, and it aims at offering the optical switching element which has the configuration which ensured switching at the same time it prevents the problem of the above-mentioned adsorption.

[0013]
[Means for Solving the Problem] (1) The light guide section which the optical element of this invention carried out total reflection of the introductory light, and was equipped with the total reflection side which can be transmitted, The extract side of translucency movable in the 1st location close to below the extract distance that an evanescent wave leaks to said total reflection side, and the 2nd location left beyond said extract distance, It has the driving means to which said extract side is made to move, and is characterized by providing one or more layers as for which a refractive index becomes both total reflection both [either or] which face said extract side or said extract side further higher than said total reflection side and said extract side from

the water-repellent quality of the material.
[0014] (2) The optical element of this invention is characterized by the quality of the material of said layer being diamond[a diamond or]-like carbon in the 1st term.
[0015] (3) The optical element of this invention is characterized by the thickness of said layer being one value of the range of 10 to 100nm in the 1st term.
[0016] (4) The light guide section which the optical element of this invention carried out total reflection of the introductory light, and was equipped with the total reflection side which can be transmitted, The extract side of translucency movable in the 1st location close to below the extract distance that an evanescent wave leaks to said total reflection side, and the 2nd location left beyond said extract distance, It is a part of driving means to which said extract side is made to move according to electrostatic force. The 1st electrode movable at said extract side and one, It has the 2nd electrode which is said a part of driving means similarly, and was fixed to said light guide section. It is characterized by providing one or more layers which said 1st electrode and said 2nd electrode are the different quality of the material, and are water repellence in both both [either or] which each of said 1st electrode or said 2nd electrode furthermore faces.
[0017] (5) The optical element of this invention is characterized by the quality of the material of said layer being diamond[a diamond or]-like carbon in the 4th term.
[0018] (6) The optical element of this invention is characterized by the quality of the material of said layer being a silicon nitride in the 4th term.
[0019]

[Embodiment of the Invention] (Example 1) The example of this invention is shown below and it explains to it using drawing.
[0020] Drawing 1 and drawing 2 are the explanatory views showing the configuration of the optical switching element which is one example of this invention.
[0021] Based on drawing 1 , it explains first. Said optical switching element consists of the conductive movable film 3 joined to the reflecting prism 2 which minds the interlayer 10 prepared in the interface of waveguide 1 and said waveguide 1, and said interlayer 10, and approaches and deserts said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6.
[0022] Here, light is supplied from the suitable light source for said waveguide 1, and total reflection and the include angle of a beam of light which carries out incidence from the light source so that it may reflect repeatedly and a beam of light may be filled, and the include angle of each field of said waveguide 1 are always designed for light in all interfaces inside. And in this condition, as long as there is nothing that approaches in a distance shorter than the wavelength of the light filled by said waveguide 1, light is confined in said waveguide 1 interior.
[0023] Now, under said waveguide 1, said reflecting prism 2 exists on drawing. Said reflecting prism 2 is joined by the upper field of said movable film 3. First, in the condition of drawing 1 , the electrical potential difference is impressed between said electrodes 7, and said movable film 3 is being attracted through said insulating layer 5 at said electrode 7 side according to electrostatic force, and is carrying out elastic deformation. Since it is joined by said movable film 3 upper part, said reflecting prism 2 has deserted said waveguide 1 with sufficient distance as drawing. In this condition, the light of said waveguide 1 interior is confined in said waveguide 1 interior, and it does not leak and come out of it outside. This is made into a condition 1.

[0024] To a degree It explains based on drawing 2 . Drawing 2 shows the situation of said optical switching element at the time of canceling the electrical potential difference currently impressed between said movable film 3 and said electrodes 7 in said condition 1. A suction force is lost by discharge of said applied voltage, and said movable film 3 which was carrying out elastic deformation is pushing up said reflecting prism 2 with tension. Thereby, said reflecting prism 2 is pushed against said waveguide 1, or is made to approach through said interlayer 10, and the so-called evanescent wave coupling produces it between said waveguide 1 and said reflecting prism 2. That is, the light of said waveguide 1 interior will ooze out to said reflecting prism 2. Furthermore, it is reflected by said reflecting prism 2, and said EBANESSENTO light which oozed out penetrates said waveguide 1, and it carries out outgoing radiation outside. In other words, the light confined in said waveguide 1 is taken out. This is made into a condition 2.
[0025] Optical switching can be performed if an above-mentioned condition 1 and an above-mentioned condition 2 are controlled by impression and discharge of said electrical potential difference. Moreover, if much aforementioned configurations are arranged in the shape of a matrix, it cannot be overemphasized that the display of an image is possible.
[0026] In addition, in this example, although said movable film 3 and said reflecting prism 2 are elastically supported by the elasticity of said movable film 3 self, needless to say, they may be separately made the configuration using supporter material or a support device. Moreover, approaches various in addition to the approach by the electrostatic force which showed said waveguide 1 and said reflecting prism 2 to drawing 1 and drawing 2 also about the device in which you make it approach and desert can be considered. For example, the approach by the piezoelectric device like a piezo actuator and an electromagnetic approach may be used.
[0027] Now, it is at the conventional optical switching element, There was a problem which causes the malfunction by adsorption of said waveguide 1 and said reflecting prism 2 as already stated. Furthermore, in the field of said reflecting prism 2 and opposite side, there was fear of adsorption similarly. The main causes of said adsorption are adhesion of the moisture in a contact part. Therefore, at the time of manufacture, removal of moisture is important, and it had to cope with manufacturing or giving a still more chemical water-repellent finish to the contact surface in the environment dried enough, etc. Furthermore, said component needed to be closed with a package after that, and needed to prevent mixing of future moisture. However, in order to realize the fully dried above manufacture environments, the large-scale facility was required. Moreover, operation of such a facility requires a great quantity of energy, and is contrary to energy saving and the demand to a manufacture in recent years called environmental preservation. On the other hand, the aforementioned chemical water-repellent finish is a process which requires long time amount, and the waste fluid discharged by using the chemical of about [having become the factor of a cost rise] and many caused environmental destruction. Furthermore, the class of chemical used for a water-repellent finish may have caused environmental pollution also on the occasion of abandonment of a product.
[0028] However, at this example, adsorption is prevented with the easy configuration by considering as the configuration which allotted said interlayer 10 constituted from the pile quality of the material by the lifting in adsorption between said waveguides 1 and said reflecting prisms 2. Therefore, energy of a large-scale manufacturing facility or many is not needed, but a low cost optical switching element is realized. Moreover, as said interlayer 10, if the diamond film or DLC (Diamond Like Carbon) is used, since these are the quality of the materials which cannot be charged easily, not only the adsorption by moisture but the adsorption by static electricity is prevented, and they can be made into the optical switching element which was

repeatedly excellent also in endurance further here. Here, if it is the diamond film, since permeability is high, quantity of light loss can be made small. On the other hand, if it is DLC, membranes can be formed easily and it can mass-produce at low cost. Moreover, since said diamond film and said DLC are carbon, they are harmless also to a living body, and they do not cause environmental destruction by abandonment of waste fluid or a product.

[0029] Furthermore, when said interlayer's 10 refractive index is higher than said waveguide 1 or said reflecting prism 2, another useful effectiveness can be acquired. This point is explained below.

[0030] In the conventional optical switching element adapting the above evanescent wave coupling, since the strength of the evanescent wave which oozes out from said waveguide 1 decreased quickly exponentially to distance, there was [a problem of having to make said waveguide 1 and said reflecting prism 2 approach enough for taking out light]. However, since dispersion in distance etc. existed when two or more errors at the time of manufacture, surface roughness of a field, and said reflecting prisms 2 are put in order in fact, it was difficult to realize always enough and uniform approach. Consequently, there was a possibility of sufficient quantity of light not having been obtained or producing big dispersion in the quantity of light.

[0031] However, if it is made the configuration which has said interlayer 10 like this example, and glass is used for said waveguide 1 or said reflecting prism 2 and what has a refractive index higher than a diamond or glass like DLC is used for said interlayer 10 as the quality of the material as shown below, the above-mentioned problem is improvable. This situation is shown in drawing 3 . When said interlayer 10 of 11 curve which is a continuous line cannot be found, change of the quantity of light P to the distance x of said waveguide 1 and said reflecting prism 2 in case said interlayer 10 has the curve 12 which is a dotted line taken out from said waveguide 1 is shown. First, when said interlayer 10 cannot be found, the quantity of light taken out is max when distance is 0, and, moreover, shows a sharp peak. And monotone reduction is quickly carried out as distance increases after that. On the other hand, when there is said interlayer 10, it has a loose peak in a certain distance, and becomes the curve which decreases gently-sloping. especially -- it should observe -- it is the point that the quantity of light taken out from a certain distance x1 rather than the case where said interlayer 10 cannot be found, in the range of x2 is large. That is, this shows that it is made stopping the degree of loss of power small, and to increase even if the case where said waveguide 1 and said reflecting prism 2 are not approached enough arises, and it gets by the roughness of an error or a field, dispersion, etc. in said optical switching element. Moreover, since the curve of a peak part becomes loose as aforementioned, it is said waveguide 1 and said reflecting prism 2. Fluctuation of the quantity of light taken out also to dispersion in distance decreases. In other words, the margin to dispersion in distance can be extended. This has effectiveness in stopping the nonuniformity of the brightness between pixels, when many optical switching elements of this example are arranged the shape of an array, and in the shape of a matrix and an image display device etc. is constituted.

[0032] Moreover, by making said interlayer's 10 thickness into a suitable value, the quantity of light in the target distance which can be taken out can be made into max, or dispersion over distance can be made into min here. This situation is shown in drawing 4 . When there is no curve 11 of said ten interlayer on drawing, the curve 14 of a curve 13 is the case where said interlayer's 10 optical thickness is 1/3 of wavelength for a curve 15 when said interlayer's 10 optical thickness is [said interlayer's 10 optical thickness] 1/8 of wavelength 1 / 30 case of wavelength. With optical thickness, physical thickness, i.e., an absolute size and a refractive index, is applied here. The curve of the quantity of light taken out changes with said interlayer's

addition to the curve which decreases gently-sloping with a loose peak from what shows a sharp high peak in a certain distance, when distance is 0. Moreover, if said interlayer's thickness is changed so that drawing 4 may see, the configuration of said curve will also change. That is, with said curve 13 whose optical thickness of said interlayer 10 is 1 / 30 case of wavelength, migration and slowdown of a peak are seen to the curve 11 which is the case where said interlayer 10 cannot be found, and also the value of a peak falls. With said curve 14 which is the case where said interlayer's 10 optical thickness is 1/8 of wavelength, migration of a peak and the fall of slowdown and peak value are further seen to a curve 13. With said curve 15 which is the case where said interlayer's 10 optical thickness is 1/3 of wavelength, the curvilinear configuration near a peak will become extremely gently-sloping, and the quantity of light will decrease to the whole. If the above curve is compared, in x0, a curve 11 serves as the maximum quantity of light from distance 0, and it is the most advantageous. Similarly, in distance x1 to x2, a curve 14 has the curve 13 most advantageous at x1 from distance x0. Then, by the distance of said waveguide 1 expected when actually manufacturing or manufacturing an optical switching element, and said reflecting prism and its error, the roughness of an interface, dispersion, etc., if said suitable interlayer's thickness is chosen, light can be taken out most efficiently. If drawing 4 is followed and the distance of said waveguide 1 generally expected and said reflecting prism and its error, the roughness of an interface, and dispersion will be taken into consideration, it is appropriate that said interlayer's 10 optical thickness considers as either between 1/30 and 1/3 of wavelength. When the quality of the material before and behind said diamond film or a refractive index 2.2 like said DLC is used, it is still more specifically appropriate for the thickness to consider as one value of the range of 10 to 100nm. There is no malfunction by adsorption of said waveguide 1 and said reflecting prism 2 by this, and it is possible that there is little dispersion in the quantity of light or to realize said optical switching element from which light can be taken out efficiently.
[0033] In addition, although this example showed the optical switching element of a configuration of making said reflecting prism 2 approach said waveguide 1, making said EBANESSENTO light which oozed out reflect with said reflecting prism 2, penetrating said waveguide 1, and taking out outside, idea ****** are variously made as for the structure of the optical switching element using said evanescent wave coupling to others. For example, it can consider as the optical member which makes said reflecting prism in drawing 1 reflect not but penetrate, and the optical switching element which is made to penetrate said EBANESSENTO light and takes out said movable film 3, said insulating layer 5, said electrode 7, and said substrate 6 to said transparence member, then substrate 6 side can be constituted. And if said interlayer who has suitable thickness as shown in the interface which performs said evanescent wave coupling by this example is inserted even if it is in the optical switching element of ******** or a configuration of becoming, the same effectiveness as this example, i.e., the malfunction by adsorption, cannot be found, and it cannot be overemphasized that there is little dispersion in the quantity of light or that the effectiveness that light can be taken out efficiently is acquired.
[0034] (Example 2) Drawing 5 and drawing 6 are the explanatory views showing the configuration of the optical switching element which is other one example of this invention. In the example 1, although said interlayer 10 was formed in said waveguide 1 side, as shown in drawing 5 and drawing 6 , said interlayer 10 may be formed in said reflecting prism 2 side.
[0035] Said optical switching element of this example possesses an interlayer 10 in the field which faces the waveguide 1 with which the beam of light which carried out incidence from the

suitable light source is filled, and said waveguide 1, and consists of the conductive movable film 3 joined to the reflecting prism 2 which minds said interlayer 10, and approaches and deserts said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. This example can acquire the same effectiveness as an example 1, and can form said interlayer 10 more easily depending on the production process of said optical switching element. Since it is the same as that of an example 1 about other configurations and effectiveness, detailed explanation is omitted.

[0036] (Example 3) Drawing 7 and drawing 8 are the explanatory views showing the configuration of the optical switching element which is other one example of this invention. In the example 1, although the diamond film or DLC was used as the middle class 10, a silicon nitride may be used instead.

[0037] Said optical switching element of this example consists of the conductive movable film 3 joined to the reflecting prism 2 which minds the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, the interlayer 10 who consists of a silicon nitride prepared in the interface of said waveguide 1, and said interlayer 10, and approaches and deserts said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. In this example, the adsorption prevention effectiveness as well as an example 1 can be acquired, and also since said silicon nitride has also generalized a membrane formation technique and equipment, it can form an interlayer 10 easily and cheaply. Since it is the same as that of an example 1 about other configurations, detailed explanation is omitted.

[0038] (Example 4) Drawing 9 and drawing 10 are the explanatory views showing the configuration of the optical switching element which is other one example of this invention. This example changes said middle class 10 of the configuration of an example 2 into a silicon nitride from the diamond film, the diamond film, or DLC.

[0039] Said optical switching element of this example possesses an interlayer 10 in the field which faces the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, and said waveguide 1, and consists of the conductive movable film 3 joined to the reflecting prism 2 which minds said interlayer 10, and approaches and deserts said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. In this example, an interlayer 10 can be formed easily and cheaply like an example 3. Since it is the same as that of an example 2 about other configurations, detailed explanation is omitted.

[0040] (Example 5) Drawing 11 is the explanatory view showing the configuration of the optical switching element which is other one example of this invention.

[0041] In this optical switching element shown in examples 1-4, contact and dissociation actuation are performed a field opposite to said reflecting prism 2 of said movable film 3, said electrode 7, and in between. Therefore, also in this part, there is a possibility of causing adsorption, like said reflecting prism 2 side. Then, as shown in this example, the addition layer 16 which becomes a lifting from the pile matter about adsorption may be formed in the field which faces said electrode 7 of said movable film 3, and you may make it the configuration which prevents out of control [by adsorption], and property degradation.

[0042] Said optical switching element The addition layer 16, substrate 6 which were added to the field opposite to said reflecting prism 2 of the conductive movable film 3 joined to the reflecting prism 2 which approaches and deserts the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, and said waveguide 1, and said

reflecting prism 2, and said movable film 3 being joined, It consists of an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. As an example of the quality of the material of said addition layer 16, the diamond film or DLC, a silicon nitride, etc. are mentioned like the aforementioned example. According to the effectiveness of said addition layer 16, out of control [by adsorption] and property degradation are prevented also in a field opposite to said reflecting prism 2 of said movable film 3, and the optical switching element excellent in endurance and dependability is realized.

[0043] Moreover, if the diamond film, DLC, or an insulator like a silicon nitride is used as said addition layer 16, said addition layer 16 can serve as said insulating layer 5, and can be compatible in an insulating device and adsorption prevention with an easy configuration. Moreover, if this configuration is combined with the configuration of examples 1-4, said optical switching element which prevented said waveguide 1 and adsorption of said reflecting prism 2, and adsorption of said movable film 3 and said electrode 7 to coincidence is realizable.

[0044] Since it is the same as that of an example 1 about other configurations and effectiveness, detailed explanation is omitted.

[0045] (Example 6) Drawing 12 is the explanatory view showing the configuration of the optical switching element which is other one example of this invention.

[0046] Although the addition layer 16 which prevents adsorption with said electrode 7 of said movable film 3 was added to said movable film 3 side in the example 5, as shown in this example, you may make it the configuration added to said electrode 7 side.

[0047] Said optical switching element consists of an addition layer 16 added to the field which faces said movable film 3 of the conductive movable film 3 joined to the reflecting prism 2 which approaches and deserts the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, and said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, and said electrode 7, an insulating layer 5, and a spacer 4 which prepares space between said movable film 3 and substrates 6. As an example of the quality of the material of said addition layer 16, the diamond film or DLC, a silicon nitride, etc. are mentioned like the aforementioned example. According to the effectiveness of said addition layer 16, out of control [by adsorption] and property degradation are prevented also in a field opposite to said reflecting prism 2 of said movable film 3, and the optical switching element excellent in endurance and dependability is realized.

[0048] Moreover, if the diamond film, DLC, or an insulator like a silicon nitride is used as said addition layer 16 as the example 5 also described, said addition layer 16 can serve as said insulating layer, and can be compatible in an insulation and adsorption prevention with an easy configuration.

[0049] Moreover, if this configuration is combined with the configuration of examples 1-4 like an example 5, said optical switching element which prevented said waveguide 1 and adsorption of said reflecting prism 2, and adsorption of said movable film 3 and said electrode 7 to coincidence is realizable.

[0050] Since it is the same as that of an example 1 about other configurations and effectiveness, detailed explanation is omitted.

[0051] (Example 7) Drawing 13 is the explanatory view showing the configuration of the optical switching element which is other one example of this invention. Although said interlayer 10 was formed in said waveguide 1 side in the example 1 and said interlayer 10 was formed in said reflecting prism 2 side in the example 2, as drawing 13 was carried out, said interlayer 10 may be formed in both said waveguide 1 and said reflecting prism 2.

[0052] Said optical switching element of this example possesses the 2nd interlayer 18 in the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, the 1st interlayer 17 prepared in the interface of said waveguide 1, and the interface which faces said waveguide 1. It consists of the conductive movable film 3 joined to the reflecting prism 2 which minds said 1st interlayer 17 and said 2nd interlayer 18, and approaches and deserts said waveguide 1, and said reflecting prism 2, a substrate 6, an electrode 7, an insulating layer 5, and a spacer 4 that prepares space between said movable film 3 and substrates 6. In this example, adsorption can be prevented still more certainly than an example 1 and an example 2 by using the quality of the material which cannot stick [silicon nitride / the diamond film or DLC,] to said 1st middle class 17 and said 2nd middle class 18 easily. Furthermore, if the case where said waveguide and said reflecting prism 2 cannot contact with surface roughness, dispersion at the time of manufacture, etc. arises, reflection may occur on the front face of said reflecting prism 2, quantity of light loss may be caused as a result, but in this example, since it is possible to carry out acid resisting by designing the thickness of said 1st interlayer 17 and the 2nd interlayer 18 the optimal, more efficient evanescent wave coupling is realizable. Furthermore, the acid-resisting effectiveness may be heightened by multilayering. Since it is the same as that of an example 1 about other configurations and effectiveness, detailed explanation is omitted.

[0053] (Example 8) Drawing 14 is the explanatory view showing the configuration of the optical switching element which is other one example of this invention.

[0054] Although the addition layer 16 which becomes a lifting from the pile matter about adsorption in the example 5 was formed in the field which faces said electrode 7 of said movable film 3 and being formed in said electrode 7 side in the example 6 on the other hand, needless to say, said addition layer may be formed in the both.

[0055] Said optical switching element The 1st addition layer 19, substrate 6 which were added to the field opposite to said reflecting prism 2 of the conductive movable film 3 joined to the reflecting prism 2 which approaches and deserts the waveguide 1 with which the beam of light which carried out incidence from the suitable light source is filled, and said waveguide 1, and said reflecting prism 2, and said movable film being joined, It consists of a 2nd addition layer 20 added to the field which faces said movable film 3 of an electrode 7 and said electrode 7, an insulating layer 5, and a spacer 4 which prepares space between said movable film 3 and substrates 6.

[0056] In this example, since it becomes a lifting with approach by pile matter, and estrangement about adsorption, adsorption is prevented still more highly and the optical switching element which was more excellent in endurance and dependability is realized. Moreover, although it may be necessary in actual membrane formation to insert a layer which is often different for convenience' sake on manufacture in addition to the target layer, said 1st addition layer 19 and the 2nd addition layer 20 may be multilayered in that case. Since it is the same as that of other examples about other configurations and effectiveness, detailed explanation is omitted.

[0057]

[Effect of the Invention] According to this invention, the effectiveness taken below is brought about.

[0058] (1) The optical element of this invention can be manufactured for the configuration which prevents adsorption by adding the waveguide which approaches and deserts, and the interlayer

constituted from the pile quality of the material by the lifting in adsorption between reflecting prisms, without using a large-scale facility. Therefore, since a low cost optical switching element is realized, excelling in endurance repeatedly and also the energy which manufacture takes compared with the conventional product is reduced, it excels also from a viewpoint of environmental preservation. Furthermore, even if the case where said waveguide and said reflecting prism do not approach enough arises by the error at the time of manufacture, dispersion of distance with said waveguide at the time of putting two or more roughness of a field, and said reflecting prisms in order, etc., the degree and dispersion of loss of power can be small suppressed by work of said interlayer. It is possible to realize said optical switching element from which dispersion in the quantity of light can take out light few most efficiently by considering as either between 1/30 and 1/3 of the wavelength of the light which is going to take out said interlayer's optical thickness especially. As a result, the yield also improves and productive efficiency is also improved sharply. Moreover, if the diamond film or DLC is used as said interlayer, not only the adsorption by moisture but the adsorption by static electricity will be prevented. Therefore, it can consider as the optical switching element which was repeatedly excellent also in endurance further. Moreover, since the diamond film and DLC are carbon, they are harmless also to a living body, and they do not cause environmental destruction by abandonment of waste fluid or a product.

[0059] (2) The optical element of this invention forms said interlayer in said waveguide side, and also may be formed in said reflecting prism side, As a result, both can acquire the same effectiveness, and if the above is chosen by the production process, said interlayer can be formed more easily.

[0060] (3) In the optical element of this invention, when a silicon nitride is used as the middle class, since said silicon nitride has also generalized a membrane formation technique and equipment, while it can acquire the adsorption prevention effectiveness more easily like the case of the diamond film or DLC, it can form said middle class more easily and cheaply.

[0061] (4) In the optical element of this invention, also in a field opposite to said reflecting prism of said movable film, when the addition layer which becomes a lifting from matter, such as pile diamond film or DLC, and a silicon nitride, about adsorption is formed in the field which faces said electrode of said movable film, the malfunction by adsorption is prevented also in said field, and the optical switching element excellent in endurance and dependability is realized. Moreover, when the diamond film or an insulator like DLC is used as said addition layer, said addition layer can serve as said insulating layer, and can be compatible in an insulating device and adsorption prevention with an easy configuration.

[0062] (5) In the optical element of this invention, if the addition layer which consists of the diamond film which prevents adsorption with said electrode of said movable film or DLC, a silicon nitride, etc. is added to said electrode side, in a field opposite to said reflecting prism of said movable film, out of control [by adsorption] and property degradation will be prevented like the preceding clause, and the optical switching element excellent in endurance and dependability will be realized. Moreover, if the diamond film or DLC, and an insulator like a silicon nitride are used as said addition layer, said addition layer can serve as said insulating layer, and can be compatible in an insulation and adsorption prevention with an easy configuration.

[0063] (6) If said interlayer is formed in both said waveguide and said reflecting prism, adsorption can be prevented still more certainly. Moreover, since it is possible to carry out acid resisting by designing the thickness of a layer the optimal, an optical switching element with the

more high effectiveness of evanescent wave coupling is realizable. Furthermore, it is possible by multilayering to heighten the acid-resisting effectiveness and to constitute an efficient optical switching element.
[0064] (7) adsorption -- a lifting -- being hard -- if the addition layer 16 which consists of matter is formed in the field which faces said electrode of said movable film and it forms also in said electrode 7 side further -- adsorption -- a lifting -- being hard -- since it becomes approach by matter, and estrangement, adsorption is prevented still more highly and the optical switching element which was more excellent in endurance and dependability is realized.

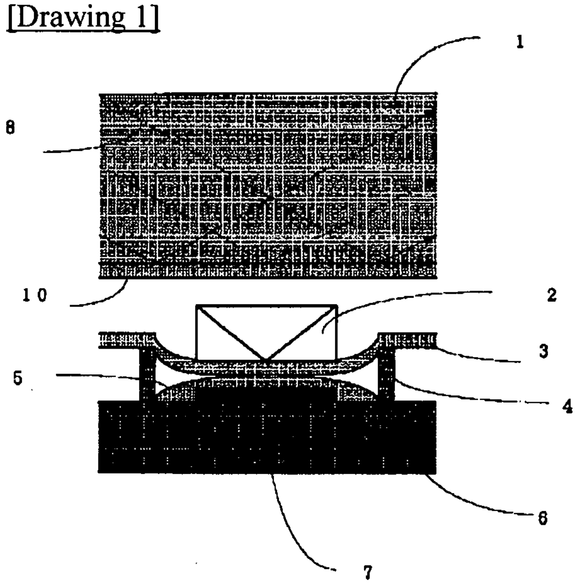
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The explanatory view showing one example of the optical element of this invention.
[Drawing 2] The explanatory view showing one example of the optical element of this invention.
[Drawing 3] The explanatory view for explaining one example of the optical element of this invention.
[Drawing 4] The explanatory view for explaining one example of the optical element of this invention.
[Drawing 5] The explanatory view showing other one example of the optical element of this invention.
[Drawing 6] The explanatory view showing other one example of the optical element of this invention.
[Drawing 7] The explanatory view showing other one example of the optical element of this invention.
[Drawing 8] The explanatory view showing other one example of the optical element of this invention.
[Drawing 9] The explanatory view showing other one example of the optical element of this invention.
[Drawing 10] The explanatory view showing other one example of the optical element of this invention.
[Drawing 11] The explanatory view showing other one example of the optical element of this invention.
[Drawing 12] The explanatory view showing other one example of the optical element of this invention.
[Drawing 13] The explanatory view showing other one example of the optical element of this invention.
[Drawing 14] The explanatory view showing other one example of the optical element of this invention.
[Drawing 15] The explanatory view showing an example of the conventional optical element.
[Drawing 16] The explanatory view showing an example of the conventional optical element.
[Drawing 17] The explanatory view for explaining an example of the conventional optical element.

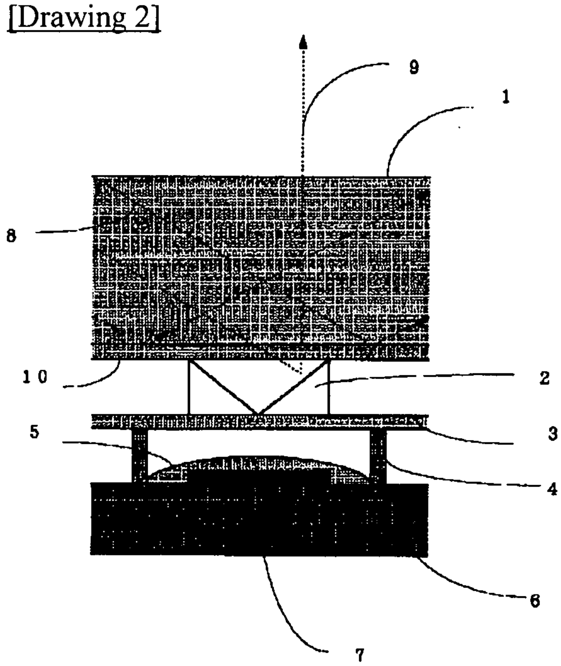
[Description of Notations]
1 Waveguide
2 Reflecting Prism
3 Movable Film
4 Spacer
5 Insulating Layer
6 Substrate
7 Electrode
8 Incident Light
9 Reflected Light
10 Interlayer
11 Curve in case There is No Interlayer
12 Curve in case There is an Interlayer
13 Curve in case Interlayer's Optical Thickness is 1/30 of Wavelength of Light
14 Curve in case Interlayer's Optical Thickness is 1/8 of Wavelength of Light
15 Curve in case Interlayer's Optical Thickness is 1/3 of Wavelength of Light
16 Addition Layer
17 1st Interlayer
18 2nd Interlayer
19 1st Addition Layer
20 2nd Addition Layer

DRAWINGS

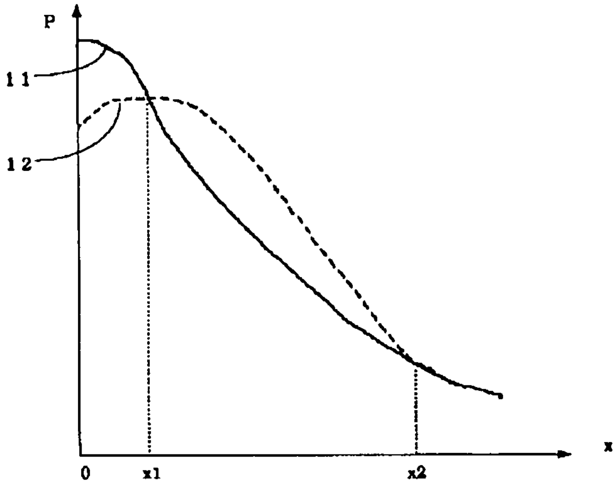
[Drawing 1]



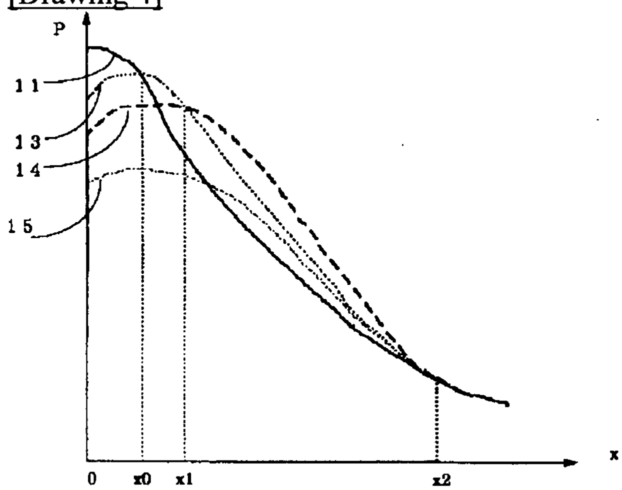
[Drawing 2]



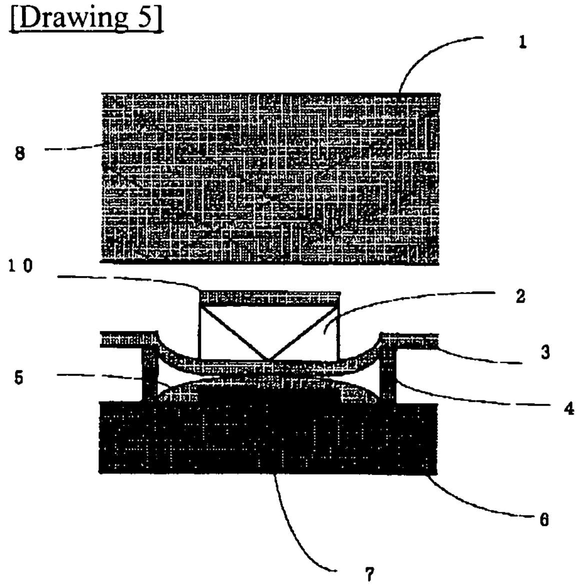
[Drawing 3]



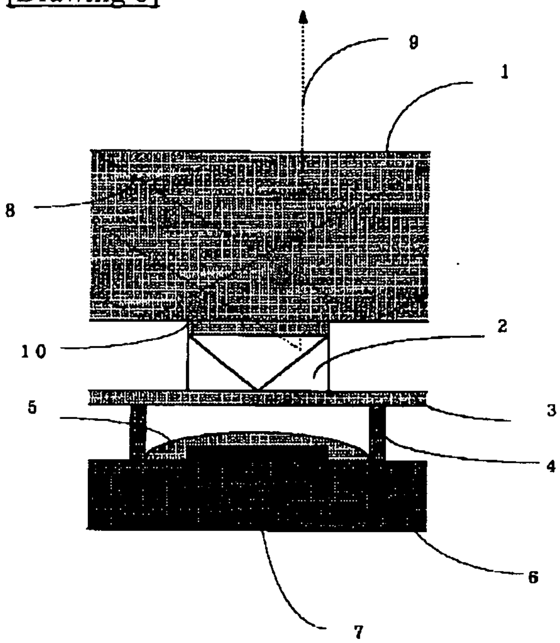
[Drawing 4]



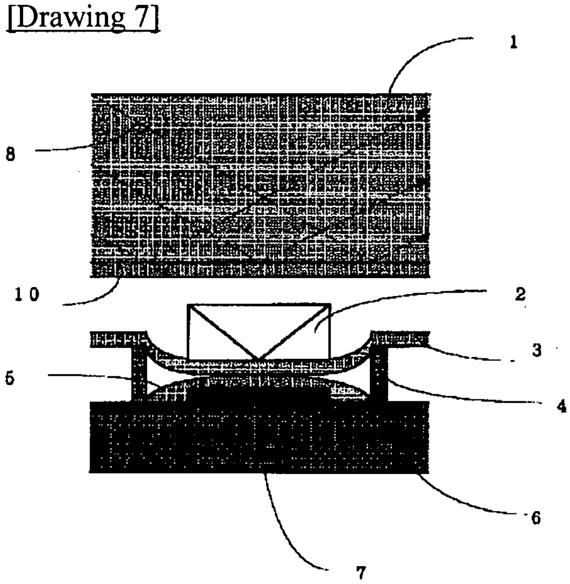
[Drawing 5]



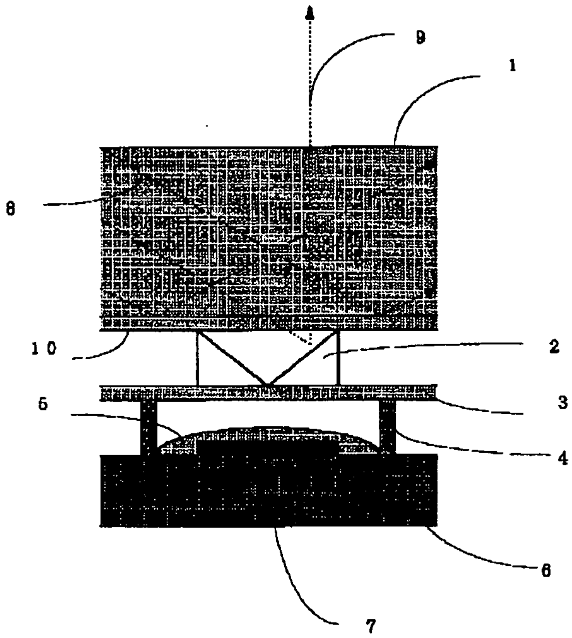
[Drawing 6]



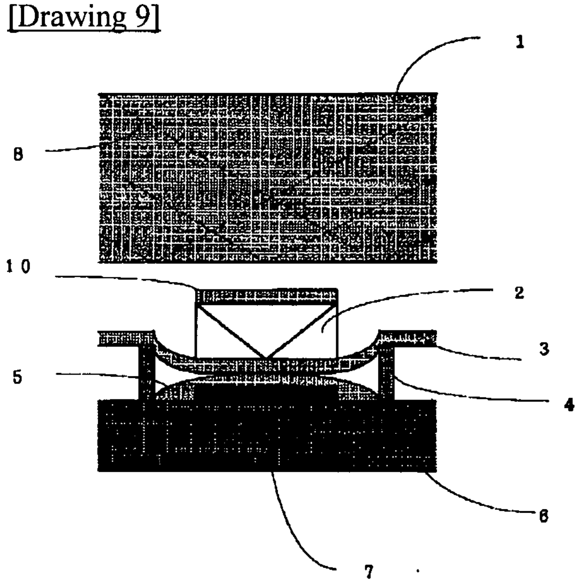
[Drawing 7]



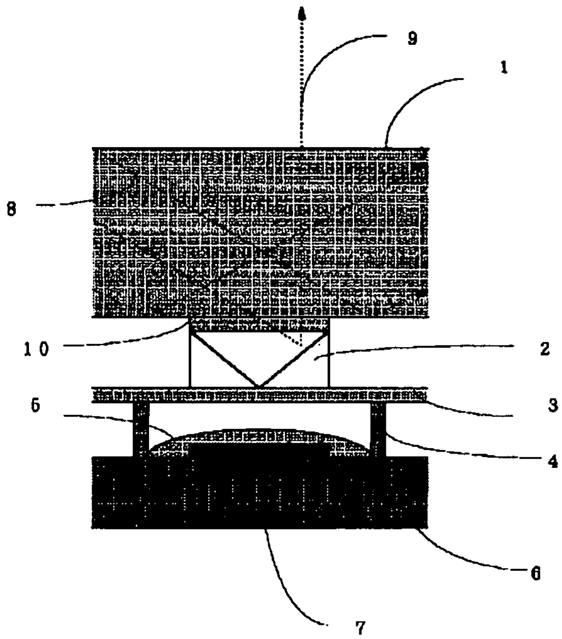
[Drawing 8]



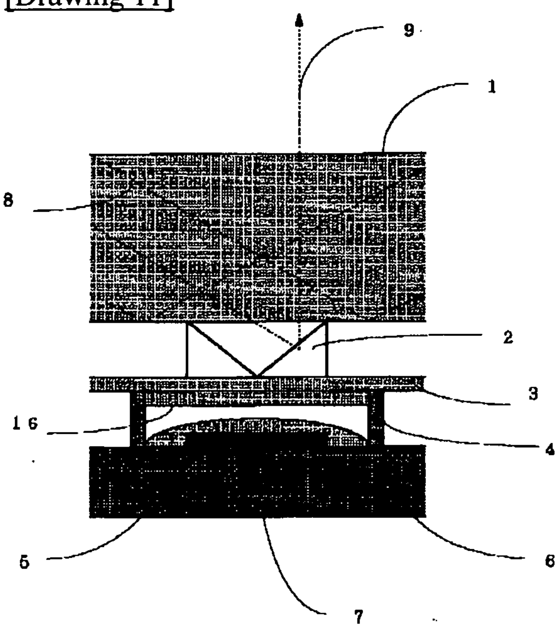
[Drawing 9]



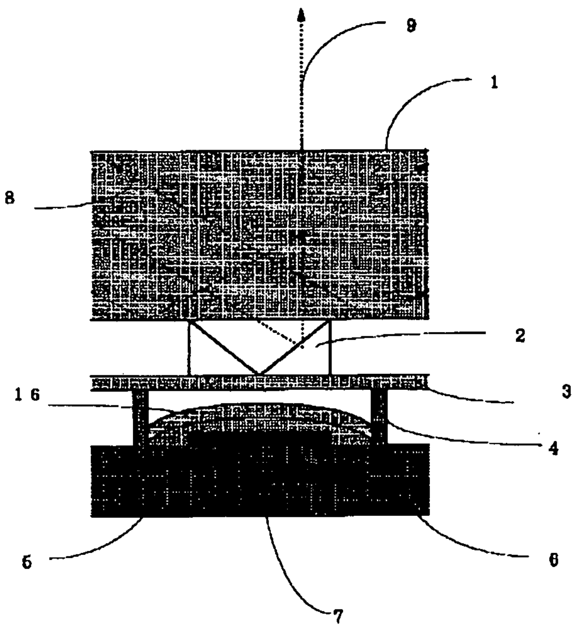
[Drawing 10]



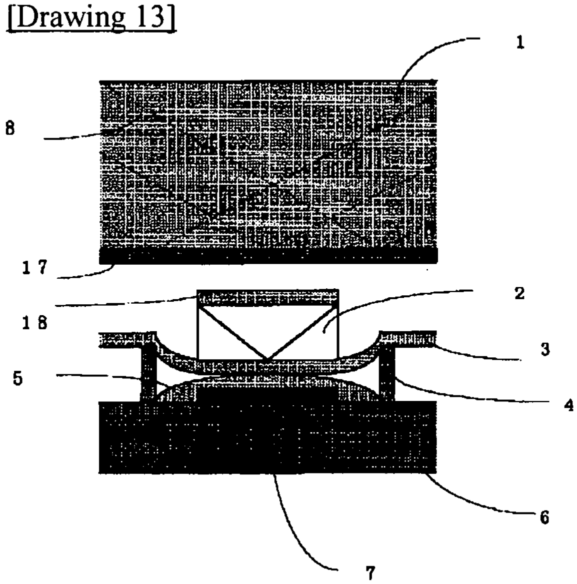
[Drawing 11]



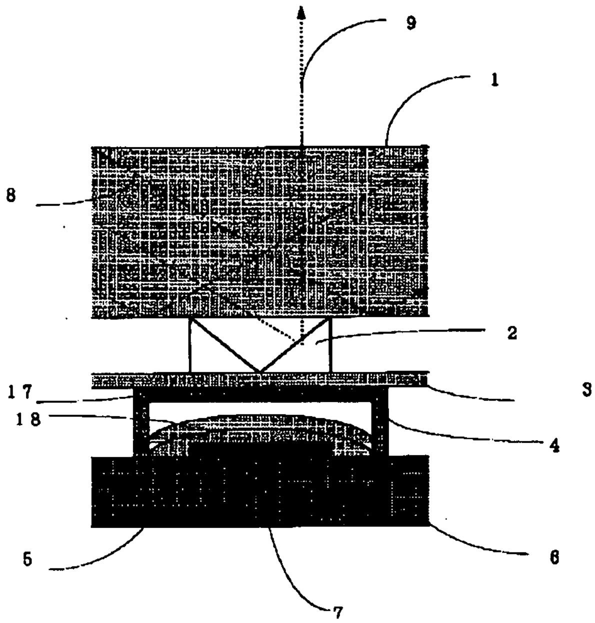
[Drawing 12]



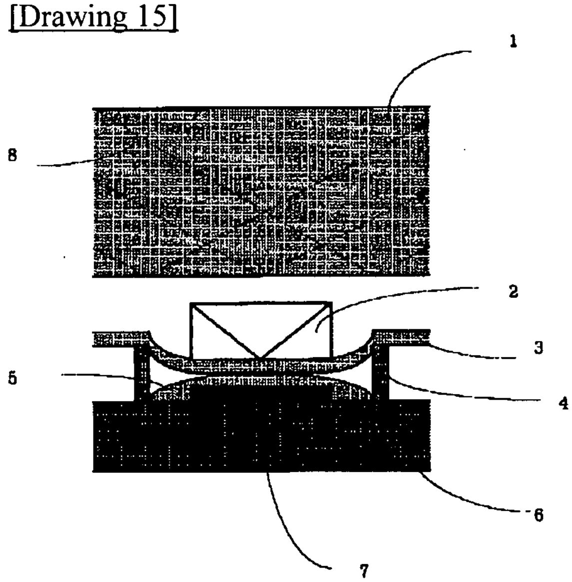
[Drawing 13]



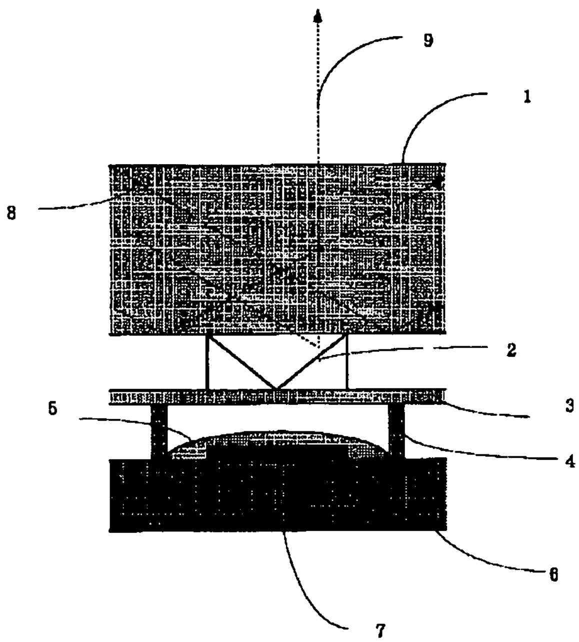
[Drawing 14]



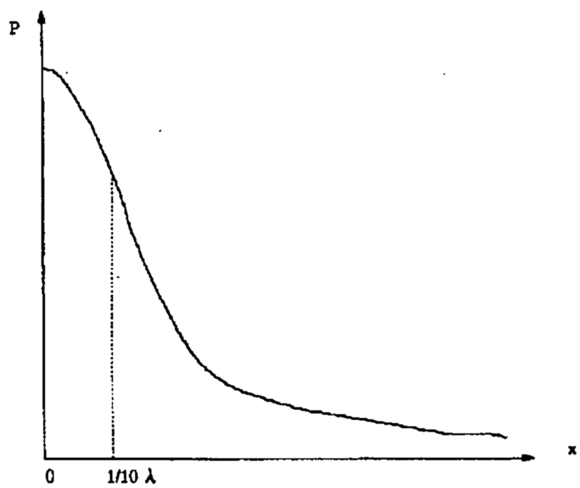
[Drawing 15]



[Drawing 16]



[Drawing 17]



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